Deindustrialization, Reindustrialization and Environmental Degradation: Evidence from Ecological Footprint of Turkey

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ABSTRACT

As in most developing countries, Turkey has witnessed the deindustrialization process in 1990s. However, unlike the others, the reindustrialization experience has started in the country since 2002. Despite the existence of some arguments about the environmental impact of such structural changes, they are mostly ignored by empirical studies. For this purpose, the main purpose of this study is to examine the impact of structural changes on environmental degradation in Turkey for the period from 1970 to 2017. In addition, the impact of real income, urbanization and human capital on environmental degradation is also observed. In doing so, the study employs the NARDL approach to clearly obtain the impact of industrialization with both positive and negative shocks. Moreover, both CO_2 emission and ecological footprint are used as the indicator of environmental degradation to compare the environmental impact of structural transformation on different degradation indicators. The findings show that deindustrialization results in reduced carbon emissions, but with no significant impact on ecological footprint. Furthermore, we discovered that while both industrialization and reindustrialization lead to lower environmental quality, reindustrialization holds the potential to be less harmful to the environment because of advancements in technology.

Keywords: Deindustrialization, Reindustrialization, CO_2 emission, Ecological footprint, NARDL, Turkey

1. Introduction

Industrialization strategies that prioritize enrichment than environmental consciousness or technological developments that aims to reduce environmental degradation are explained by the Environmental Kuznets Curve (EKC) hypothesis which is first scrutinized by Grossman and Krueger (1991) and the hypothesis has become a popular research topic in recent years and associates environmental changes with the economic performance of countries. The hypothesis claims that the effects of economic activities on environmental degradation are determined in three stages. In the first stage where the scale effect is valid, the increase in production is possible with high levels of input and excessive natural resource destruction, as the level of technology has not yet reached sufficient maturity thus environmental degradation increases. In second stage, the impact of economic activities on environment changes depending on the structural change in the economy and therefore the stage is called as composition effect. At this stage, the weight in the economy has changed from the agricultural sector to the industrial sector or from the industrial sector to the service sector. Finally, the technological effect stage is considered as the stage where the economic efficiency increases and environmental destruction decreases thanks to eco-friendly technologies (Dogan and Inglesi-Lotz, 2020). The situation that attracts attention for all stages is that economic activities affect the environment through three channels; i) income elasticity of demand for environmental quality ii) increased returns from pollution-reducing technological developments iii) structural changes accompanying economic growth (Du and Xie, 2019). Considering the first two stages, an increase in environmental awareness or technological developments is expected to reduce pollution. However, the question of how the transition from the industrial sector to the service sector affects the environment in an economy that follows traditional development stages is a question that needs to be investigated.

The structural change process, which is considered as the last stage of the development processes of the countries, is explained by the transition from the industrial sector to the service sector as a result of the transition from the energy-intensive economy to the technology-intensive

economy (Tsurumi and Managi, 2010). With this process, which reflects the transformation into information-intensive industries and the service sector, existing common view argues that environmental degradation will gradually decrease as a result of increasing environmental awareness, environmental regulations, environment-friendly technologies and investments in these technologies (Panayotou, 1993). However, it is also known that the service sector may increase environmental degradation, directly or indirectly, by promoting large-scale consumption. Some leisure activities, especially the travel industry's extensive travel practices, cause serious damage to the environment. For instance, the development of the tourism sector requires large investments in infrastructure such as roads, airports and different tourism services (resorts, restaurants, hotels, marinas, shops and golf courses). Therefore, tourism has an impact on the environment, e.g. soil erosion, air and sea pollution, habitat loss, etc. (Ozturk et al., 2016). Similarly, product distribution, use of computer technologies and other leisure activities increase energy and water consumption and waste production. For these reasons, the energy consumption and global warming potential of the service sector is almost the same as the manufacturing industry (Rosenblum et al. 2000).

At this point, it is more accurate to focus on developing countries in order to observe the environmental effects of structural change because some developing countries have experienced these changes very quickly. Over the past decades, many developing countries have first experienced the industrialization process, which refers to the transformation from the dominance of the agricultural sector to the industrial sector, and then the deindustrialization process, which refers to the structural change from the industrial sector to the service sector. Rodrik (2016) claims that the deindustrialization process started earlier than it should be for many developing countries and calls this rapid transformation as premature deindustrialization. Therefore, it is also possible that countries that reduce industrialization before reaching the technological maturity level originated from the industry sector will enter the reindustrialization process for their development goals. Among developing countries, Turkey is one of the countries experiencing the most rapid

structural change. because the country has experienced industrialization, deindustrialization and even re-industrialization in only decades.

[INSERT FIGURE 1 HERE]

The structural change process of Turkey for the period from 1970 to 2017 is shown is plotted in Fig.1. As a seen, industrialization level (industrial value added % share in gross domestic product) of Turkey has been increased from 21.93% in 1970 to 32.97% in 1989. Therefore, the period of 1970-1989 can be called as "industrialization period" for Turkey. Following this increasing trend, the deindustrialization process started in the 1990s. As a matter of fact, the level of industrialization has generally been decreased from 31.06% in 1990 to 24.61% in 2002. After this period, the industrialization period has started again and the level of industrialization has followed an increasing trend, with the exception of the 2008 global crisis decrease. The industrialization level has been increased from 24.83% in 2003 to 29.20% in 2017. We called this period as "reindustrialization period" for Turkey. However, the share of service sector value added in GDP has followed an increasing trend in general. As plotted, the share of service sector has been increased from 36.28% in 1970 to 53.33% in 2017.

When we look at the Fig. 1. from an environmental standpoint, it is predicted that in the post-2003 period, industrialization will worsen the environment. Alternatively, it is critical to consider whether the increase in industrial value added in the aforementioned period is attributable to the expansion in fossil fuel resource use or technological progress. In order to analyze this current situation, a closer examination of the results of the Eurostat (2020) report reveals that the employment rates in the high-tech manufacturing sector for EU member and candidate countries and EFTA countries over the 2008-2018 period grew by an average of -0.4% per year. Despite the significant drop in EU countries, Turkey has stated that the growth rate is +5.8 percent. On country-specific reports, the increase in Turkey was found to be significantly higher than all EU

member and candidate countries and EFTA countries. In this case, the Turkish industrial added value growth seen over the last decade may be tied to recent technological advances. Even in this type of situation, environmental damage is expected to be kept to a minimum if industrialization rate increases.

Based on above reasons, the main purpose of this study is to investigate the impact of structural change (industrialization, deindustrialization and reindustrialization) of Turkey on environmental degradation. In addition to carbon emission, ecological footprint of Wachernagel and Rees (1996) has been used as an indicator of environmental degradation in order to clearly observe the environmental damage without focusing only on some environmental pollution indicators (e.g. CO_2, SO_x and NO_x). The ecological footprint is seen as a more appropriate measure representing environmental degradation than other environmental indicators (Wachernagel and Rees, 1996) and how much environment is demanded by the world's population and / or institutions (Wackernagel, 2002) simultaneously measures, grazing land, fishing grounds, forest land, settled land and carbon footprint (Lin et al 2016). Therefore, the ecological footprint has become a leading indicator for researching sustainability and resource management (Ulucak and Lin, 2017; Destek et al., 2018; Ulucak and Bilgili, 2018; Dogan et al., 2020).

The fact that the ecological footprint indicator considers cropland, grazing land, fishing grounds, forest land and built-up land along with the carbon footprint enables us to identify the damage caused by the structural change. In particular, the impact of service sector, which has an increasing weight in the economy as a result of deindustrialization, on the other environmental indicators such as forest lands, grazing lands, etc.

The contributions of this study to existing literature are threefold. i) this is the first study that investigates the environmental effect of structural changes (industrialization, deindustrialization and reindustrialization) while most of the previous studies only considers the environmental impact of industrialization. ii) unlike previous studies, this study compares the impact of structural changes on the level of carbon emission and the other environmental

degradation indicators by constructing two empirical models on carbon emissions and ecological footprint. iii) as using method of this study allows both non-linear and asymmetrical relationship, obtained empirical findings will be more robust than previous studies.

The paper is organized as follows: Section 2 reviews and summarizes the previous studies. Section 3 describes the empirical models, data and methodology. Section 4 presents and discusses the empirical results. Finally, Section 5 concludes the study with policy implications.

2. Literature Review

The researches on the relationship between structural change and the environment is mostly examined in the focus of the effects of industrialization on carbon emissions. Therefore, it can be said that most of previous studies ignore deindustrialization and reindustrialization processes. Most of the studies confirmed the emission increasing effect of industrialization. For instance, Cherniwchan (2012) for 157 countries, Sarkodie and Owusu (2016) for Benin, Sarkodie and Owusu (2017a) for Sierra Leone, Sarkodie and Owusu (2017b) for Senegal, Brahmasrene and Lee (2017) for 10 Southeast Asia countries, Liu and Bae (2018) for China, Al-Mulali and Ozturk (2015) for 14 MENA countries, Wang et al. (2018) for China and India, Nguyen et al. (2020) for 33 emerging economies, Anwar et al. (2020) for 33 economies that are partner countries of Belt and Road Initiative, Wang et al. (2020) for APEC countries confirmed the carbon emission increasing effect of industrialization. Similar to focused country of our study, Pata (2018a) investigated the nexus in Turkey for the period from 1974 to 2013 using with ARDL bound test and found the evidence on carbon emission increasing effect of industrialization. Pata (2018b) used ARDL method to observe the impact of industrialization on carbon emission for the period of 1971-2014 in Turkey and concluded that industrialization deteriorates the environmental quality

On the other hand, there are also some studies found the environmental pollution reducing effect of increasing industrial activities. For example, Ali et al. (2017) for Malaysia, Kim (2020) for South Korea found the evidence that industrialization increases environmental quality. Moreover,

opposite to studies which detect the significant effect of industrialization on environmental degradation, Opoku and Boachie (2020) employed the pooled mean group estimator to examine the environmental impact of industrialization in 36 African countries over the period from 1980 to 2014 and concluded that industrialization does not significantly affect carbon emissions.

Apart from the country/country group studies, the existence of studies that China has been examined at provincial level due to China's excessive emission activities in recent years is also remarkable. For example, Wang et al. (2013) argued that industrialization increases emission level in Guangdong Province of China using. Similarly, Ahmad and Zhao (2018) observed the 30 Chinese provinces and the results show that industrialization increases the carbon emissions.

In addition, as stated in the EKC hypothesis, the novelty of some studies is based on the view that the trend of increasing and decreasing environmental pollution is directly related to industrialization. Therefore, these studies investigated a possible parabolic relationship between industrialization and environmental degradation. For instance, Shahbaz et al. (2014) for Bangladesh, Dong et al. (2019) for 14 developed countries and Zhou and Li (2020) for 32 countries concluded that there is an inverted U-shaped relationship between industrialization and emissions. On the other hand, Abokyi et al. (2019) for Ghana and Dogan and Inglesi-Lotz (2020) for European countries found the U-shaped association between industrialization and pollution.

Furthermore, some studies focus on the causal relationship between industrialization and environmental degradation instead of regression analysis examining the effects of industrialization. Alam and Paramati (2015) examined the causal connection between industrialization on carbon emissions spanning the period from 1980 to 2012 for 18 developing countries with VECM (Vector Error Correction Model) and concluded that industrialization causes the pollution in the short-run while the causal relationship is not valid between mentioned variables in the long-run. Wang and Su (2019) tested the causal nexus between industrialization and carbon emission for the period of 1990-2015 in China using with Granger causality analysis and the findings show that there is not any causal connection between industrialization and pollution.

Finally, it is observed from previous studies, there are only two studies explore the effect of both industrialization and deindustrialization on environment. In these recent studies, Ullah et al. (2020) probed the nexus between deindustrialization and carbon emissions in Pakistan over the period of 1980-2018 by NARDL approach and found that industrialization increases emission level while deindustrialization reduces the pollution. Similar to this finding, Munir and Ameer (2020) examined the asymmetrical relationship between industrialization and environmental pollution in Pakistan for the period from 1975 to 2016 using with NARDL procedure and concluded that increasing industrialization increases carbon emission, and vice versa.

Based on the above review, it is clear that previous studies have generally examined only the effects of industrialization on the environment. Moreover, in a few studies examining the effects of de-industrialization on environment, it is seen that the effects of re-industrialization are neglected and adherence to emission levels, which generally accepted as an environmental indicator. For these reasons, it is necessary to identify the effects of industrialization, de-industrialization and re-industrialization on both emission levels and ecological footprint in order to observe the environmental effects of structural change more clearly.

3. Materials and Methodology

Based on the main research question of this study, we construct two empirical model to clearly observe the environmental impact of structural change process in Turkey. In doing so, following the study of Ullah et al. (2020), we first use the carbon dioxide emissions as dependent variable with describing this indicator as a function of economic growth, industrialization, urbanization and human capital accumulation as follows:

$$CO_t = \alpha_0 + \alpha_1 GDP_t + \alpha_2 IND_t + \alpha_3 URB_t + \alpha_4 HC_t + \varepsilon_t \quad (1)$$

and we also use second empirical model to detect environmental damage of structural change instead of just observing its emission effect as follows:

$$EF_t = \beta_0 + \beta_1 GDP_t + \beta_2 IND_t + \beta_3 URB_t + \beta_4 HC_t + \epsilon_t \quad (2)$$

where CO is used as an indicator of environmental pollution and measured in per capita carbon emissions in tons, EF is used as actual indicator of environmental degradation and measured in per capita ecological footprint in gha, GDP is used as an indicator of economic growth and measured in per capita gross domestic product in 2010 constant US dollar, IND is used as a proxy for de(industrialization) process and measured in industrial value added share in GDP, URB is used as an indicator of urbanization level of the country and measured in urban population share in total population and finally HC represents the human capital accumulation and measured in human capital index.

The sample period is used as annual data from 1970 to 2017. The data of GDP, IND and URB is sourced from World Development Indicators, EF dataset is obtained from Ecological Footprint Network, CO data is downloaded from Our World in Data and HC variable is retrieved from Penn World Table database. In order to obtain more robust results, we used the GDP variable in natural logarithmic form.

Empirical studies in environmental and energy economics literature commonly used ARDL approach because the procedure separates the short and long-run relationships. However, since this methodology considers the positive shocks of explanatory variables, we can only observe the impact industrialization process on environment. Therefore, using a methodology which both separates the short and long-run environmental impact of regressors and takes into account the positive and negative shocks of explanatory variables will serve to our main purpose with differentiating the impact of negative shocks of industrialization in other saying deindustrialization. Based on this information, we employ the nonlinear ARDL (NARDL, hereafter) procedure of Shin et al. (2014) that reports the asymmetric relationship between variables. Following the procedure, IND variable is separated into industrialization with positive shocks of industrialization (IND^{+}_{t}) and deindustrialization with negative shocks of industrialization (IND^{-}_{t}) as follows:

$$IND_t^+ = \sum_{i=1}^{t} \Delta IND_t^+ = \sum_{i=1}^{t} \max\left(\Delta IND_t^+, 0\right) \quad (3)$$

$$IND_t^- = \sum_{i=1}^{t} \Delta IND_t^- = \sum_{i=1}^{t} \max(\Delta IND_t^-, 0) \quad (4)$$

after the obtaining partial sums, if we combine the CO and EF variables into ED (environmental degradation), the asymmetric relationship between variables with NARDL procedure is computed as follows:

$$\Delta ED_t = \delta_0 + \sum_{n=0}^{p} \delta_1 \Delta ED_{t-k} + \sum_{n=0}^{p} \delta_2 \Delta IND^+{}_{t-k} + \sum_{n=0}^{p} \delta_3 \Delta IND^-{}_{t-k} +$$

$$\sum_{n=0}^{p} \delta_4 \Delta GDP_{t-k} + \sum_{n=0}^{p} \delta_5 \Delta URB_{t-k} + \sum_{n=0}^{p} \delta_6 \Delta HC_{t-k} + \pi_1 ED_{t-1} + \pi_2 IND^+{}_{t-1} +$$

$$\pi_3 IND^-{}_{t-1} + \pi_4 GDP_{t-1} + \pi_5 URB_{t-1} + \pi_6 HC_{t-1} + v_t \quad (5)$$

where δ_i indicates short-run coefficients and π_i indicates long-run coefficients. In addition, the null hypothesis of validity of short-run joint asymmetry is tested with Wald test as $\sum \delta_{2k} = \sum \delta_{3k}$ and the null hypothesis of validity of long-run asymmetry is also tested with Wald test as $\pi_2^+/\pi_1 = \pi_3^-/\pi_1$.

4. Empirical Findings

In the first step of empirical analysis, we look at the descriptive statistics of used variables as a seem in Table 1. At a first glance, it seems the minimum and maximum level of ecological footprint of Turkey are 1.792 gha and 3.393 gha in 1973 and in 2011. In case of carbon emissions, the minimum emissions (1.221 tons) and maximum emissions (5.243) correspond to the year of 1970 and 2017, respectively (see Appendix A). Even this information shows that the ecological footprint is a clearer environmental indicator than carbon emission because the year with the lowest carbon emission indicates the start year of the observation range and the year with the highest year implies final year of the sample. However, the year when the ecological footprint is minimum indicates the 1973 oil crisis, where fossil fuel consumption bottomed. Further, it is observed that especially during the 2001 and 2008 crisis periods of Turkey when industrial production and fossil fuel consumption decreased significantly, the ecological footprint values decreased significantly compared to the carbon emission values. In case of industrialization, the minimum level of industrial value-added

share in GDP is 21.9 percent in 1970 while the maximum value of it is 32.9 percent in 1989. After 1989, the deindustrialization process has been started in Turkey. Moreover, all variables except URB and HC are positively skewed and GDP has the highest skewness. It also seems that all variables exhibit platykurtic distribution.

[INSERT TABLE 1 HERE]

Next, we observe the integration order of variables by the unit root test of Ng and Perron (2001) because our estimation technique is suitable for the situation of maximum integration order of one. The unit root test results from Table 2 show that the null hypothesis of unit root is not rejected in the level form of variables. In first differences, all variables have become stationary thus it is concluded that all variables are integrated at I(1). This finding gives us a chance to use NARDL estimation technique.

[INSERT TABLE 2 HERE]

Before employing the NARDL estimation, we should observe the existence of long-run relationship between variables. When we compare our obtaining F-statistics (5.638 and 4.801) with critical values of Pesaran et al. (2001) and conclude that the cointegration relationship is confirmed among variables for both empirical models. In addition, the other diagnostics tests which are shown in Panel C of Table 3 also confirm that there is no autocorrelation and correct functional form assumptions. Finally, it should be observed both the short and long-run asymmetry between variables with Wald-statistics. Table 3 also reveals that the null hypothesis of short and long-run symmetry is rejected by WaldSR and WaldLR statistics. Therefore, the asymmetric associations are confirmed for both models.

[INSERT TABLE 3 HERE]

Based on the main purpose of the study, both the impact of positive and negative shocks of industrial value added in other words the impact of industrialization and deindustrialization on environmental degradation are shown in Table 3. In case of carbon emissions, it seems increasing real income harms environment in the short-run. In addition, industrialization increases carbon emissions while deindustrialization reduces the emission level of Turkey. However, urbanization and human capital does not significantly affect the carbon emissions in the short-run. If we look at the long-run results, it is concluded economic growth increases carbon emissions. This finding is consistent with the findings of Apergis (2016); Antonakakis et al. (2017); Shahbaz et al. (2018); Apergis et al. (2018); Destek (2019); Muhammad (2019); Balsalobre-Lorente et al. (2019); Destek and Aslan (2020); Balsalobre-Lorente et al. (2020). We also found that urbanization increases carbon emissions in the country. The finding that urbanization increases carbon emissions is also confirmed by the studies of Zhang and Lin (2012); Kasman and Duman (2015); Destek and Ozsoy (2015) and Ali et al. (2019). In industrialization perspective, it seems industrialization increases carbon emission while deindustrialization reduces it but the negative impact of deindustrialization is bigger than the positive impact of industrialization on carbon emissions. This finding on pollution increasing effect of industrialization is obtained from the studies of Aslan et al. (2018), Pata (2018a) and Pata (2018b). If we separate the short and long-run impact of industrialization, it can be said that emission increasing effect of short-run industrialization is bigger than the long-run industrialization effect of industrialization (reindustrialization). Moreover, the impact of human capital accumulation on carbon emissions is found statistically insignificant.

In case of ecological footprint, similar to the carbon emission model, economic growth and industrialization increases and deindustrialization reduces the environmental degradation in the short-run. Likewise, the impact of urbanization and human capital on environment is statistically insignificant in the short-run. In the long-run, economic growth and urbanization harms

environmental quality by increasing the ecological footprint. Ecological footprint increasing effect of economic growth is also confirmed by Destek and Okumus (2019); Destek and Sarkodie (2019); Danish et al. (2020); Destek and Sinha (2020); Sharif et al. (2020) and the footprint increasing impact of urbanization is found by the study of Al-Mulali and Ozturk (2015). If we evaluating the impact of industrial value-added on environment, contrary to the carbon emission model, it is found that industrialization increases ecological footprint while deindustrialization does not have any significant effect on environmental degradation. Similar to the carbon emission model, the environment detrimental effect of reindustrialization is smaller than industrialization because the short-run coefficient of industrialization is bigger than the long-run. Moreover, it is concluded that increasing human capital accumulation reduces the ecological footprint level of Turkey.

For the purpose of robustness check, we also employ the asymmetric causality test developed by Hatemi-J (2012) that allows the causal relationship between positive and negative shocks of variables. In doing so, we observe the causal link between industrialization and environmental degradation indicators. If we observe the causality test results from Table 4, it seems there is a causality from positive shocks of industrialization to positive shocks of carbon emissions. In addition, we also found a causality from negative shocks of industrialization to negative shocks of carbon emissions. However, there is no any causality from positive shocks of industrialization to negative shocks of carbon emissions or from negative shocks of industrialization to positive.

[INSERT TABLE 4 HERE]

In case of ecological footprint, we have an evidence that positive shocks of industrialization cause positive shocks of ecological footprint. However, unlike carbon emission model, there is not any causality from negative shocks of industrialization to negative shocks of ecological footprint. These findings are consistent with the estimation results of NARDL methodology because we also support the findings that increasing industrialization increases carbon emission and

deindustrialization reduces the pollution level. Similarly, the findings that industrialization increases ecological footprint while deindustrialization does not have any significant effect on ecological footprint are also confirmed by causality procedure.

5. Discussions

Our finding that the short-run carbon emission increasing impact of industrialization is bigger than the long-run indicates that the second industrialization experience of Turkey for the period from 2003 to 2017 is more eco-friendly than the first one which experienced between 1970-1989 in terms of emission level. In other words, it is observed that the re-industrialization process is supported by more eco-friendly technologies, increasing renewable energy usage and energy efficiency is in industrial production. In addition, the implementation of environmental regulations that encourage the use of environmentally friendly technologies to reduce environmental damage in the first industrialization process may encounter various resistance. Indeed, the increase in the use of these technologies in the reindustrialization process or the acceleration of the penetration of environmentally friendly technologies may have been caused by the deindustrialization process between the two industrialization periods. In the deindustrialization process, it is important to eliminate the sectors that are most harmful to the environment and to protect the sectors where the speed of environmentally friendly technologies is higher. Despite all these developments, it has been found that the industrial sector's emission-increasing effect is decreasing but still industrial activities increases the emission level. In addition, the finding that deindustrialization reduces the emission both in the short and long-run is an expected outcome because Turkey's industrial production is still based mainly on fossil fuels."

In case of ecological footprint, similar to the carbon emissions, the finding reveals that the impact of industrialization on ecological footprint in the short-run is greater than the long-run. Therefore, it is concluded that the reindustrialization process is less harmful to the environment than the first industrialization experience. In addition, the evidence that deindustrialization reduces the ecological footprint is possibly sourced from decreasing carbon footprint. However, it is

surprisingly found that deindustrialization does not have a significant effect on ecological footprint while it reduces carbon emissions in the long-run. This finding indicates that the transition from the industrial sector to the service sector has destroyed cropland, grazing land, fishing grounds, build-up lands and forest land. Moreover, with the transition to the service sector, it is seen that the gains obtained in terms of emissions are less than the aforementioned destructions, and therefore the ecological footprint increases despite the decreasing carbon footprint. It is possible to associate this destruction of the service sector with the sector's large-scale consumption feature such as: i) Buildings to damage the built-up lands in order to meet the needs of the service sector, ii) the destruction of the infrastructure activities of the tourism sector, especially on fishing-grounds, grazing lands and forest land, iii) the damage caused by the tourism industry on cropland caused by promoting leisure consumption, iv) destruction of the banking and education sector on forest land due to excessive use of papers.

6. Concluding Remark

This study explores the impact of structural changes (industrialization, deindustrialization and reindustrialization) on environmental degradation by incorporating economic growth, urbanization and human capital in Turkey. In doing so, both carbon dioxide emissions and ecological footprint are used as indicator of environmental degradation thus two different empirical models are analyzed for the annual period from 1970 to 2017. In empirical procedure, since the impact of deindustrialization can be observed with the coefficient of negative shocks of industrial value added and the effect of reindustrialization can be checked with the long-run coefficient of industrial value added, we employ the non-linear ARDL method that both allows asymmetric and long-run relationship between variables.

The results can be summarized with the industrialization perspective as follows: i) industrialization increases carbon emissions both in the short and long-run while long-run destructive impact of industrialization is smaller than the short-run. ii) deindustrialization reduces

carbon emissions both in the short and the long-run. iii) industrialization increases ecological footprint both in the short and long-run while short-run detrimental effect industrialization is much more than the long-run. iv) despite deindustrialization reduces the ecological footprint in the short-run, the long-run effect of deindustrialization is statistically insignificant. v) urbanization increases environmental degradation in the long-run. vi) human capital reduces the ecological footprint level of the country while it does not have a significant effect on emissions. Based on these findings, it is concluded that reindustrialization process is much more eco-friendly than the first industrialization experience of Turkey while it also harms the environment. In addition, the evidence is found as deindustrialization process reduces carbon emissions but it increases ecological footprint. This finding means the transition from the industrial sector to the service sector reduces the emissions but it has destroyed cropland, grazing land, fishing grounds, build-up lands and forest land. Furthermore, it is confirmed that the increase in human capital accumulation has created an awareness that reduces individuals' pressure on visible environmental indicators. However, the finding points out that individuals are still unconscious about their damage on emissions.

In the context of policy implications, the existing reindustrialization process should be supported with more environmentally friendly technologies, the use of renewable energy in industrial production should be encouraged and measures to ensure the efficient use of energy should be taken because the pollution reducing effect of innovations in industrial sector has already been validated by Erdogan et al. (2020). In addition, deterrence environmental taxes should be applied to businesses that maintain the production structure in the first industrialization process. On the other hand, various tax facilities and subsidies should be provided to the enterprises that have achieved the necessary transformation in production in order to encourage them. Moreover, for the possible deindustrialization wave that will come in the next decades, measures should be taken in advance and laws should be put in place to reduce the destruction of the service sector on other environmental indicators such as forest lands and agricultural lands instead of focusing only

on-carbon emissions. As for human capital, it is seen that investments that increase human capital accumulation, especially activities that increase the level of education, reduce environmental degradation, but do not have a significant effect on carbon emission. This situation shows that even individuals with a high level of education have taken visible measures to reduce environmental damage, but failed to reduce emissions. For example, individuals are conscious of the destruction of forest lands, but are unaware of the damage caused by emission-increasing activities such as unnecessary internet use. Therefore, various courses should be added to the curriculum starting from primary education in order to raise the awareness of individuals in the context of reducing carbon emissions. Various seminars and conferences should be organized for adults.

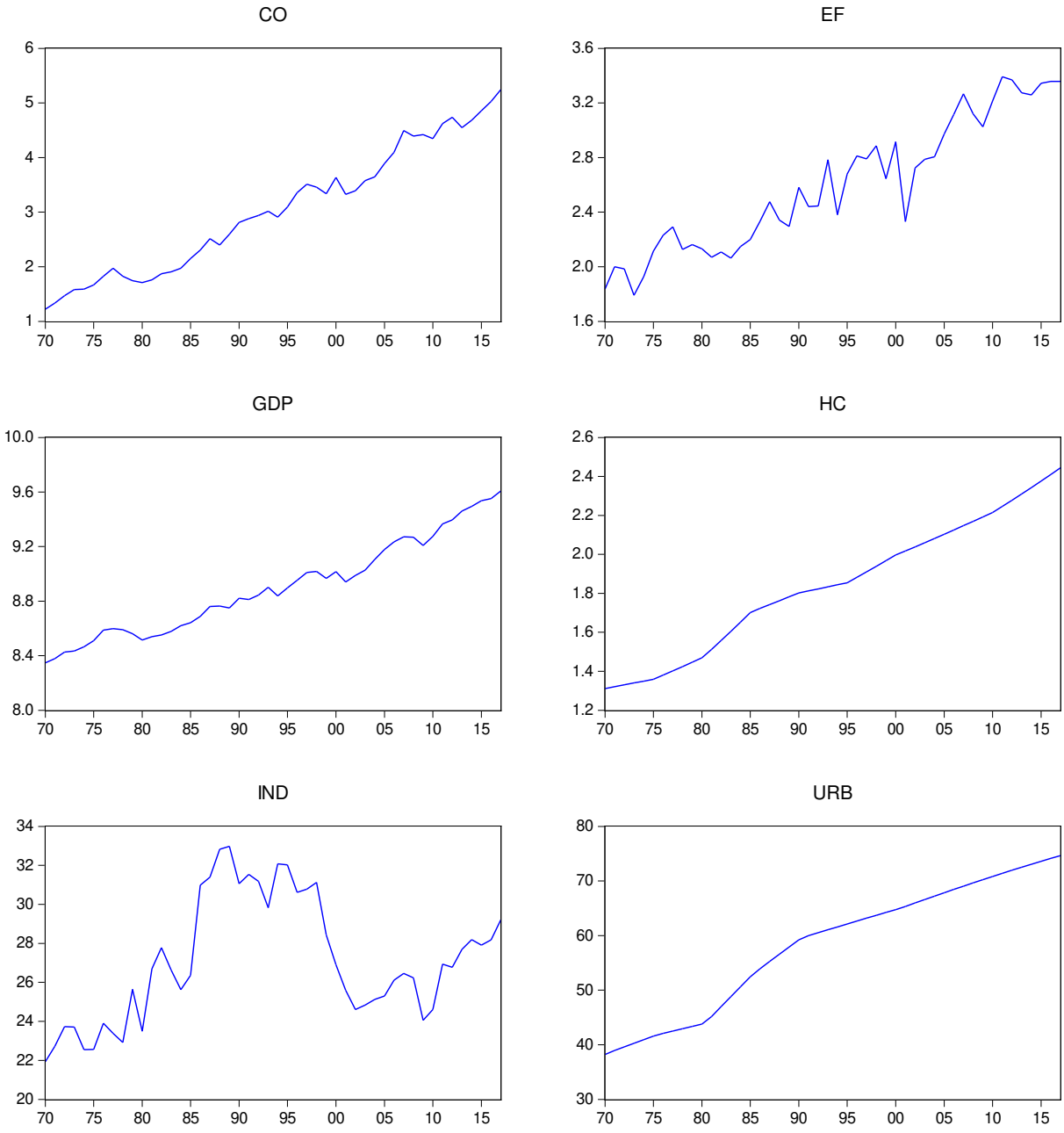
Finally, we should note about the limitations of this study to create a roadmap for future studies. Although this study only focuses on Turkey, it can lead to more dramatic findings examining the issue for all developing countries. For now, other developing countries are ignored due to lack of the adequate data. In addition, although deindustrialization is emphasized, the concept of premature deindustrialization is not emphasized in the study. In later studies, the environmental effects of premature deindustrialization can also be examined. Finally, the effects of structural change on cropland, grazing land, fishing grounds, forest land, built-up land along and carbon footprint can be compared by using subcomponents of the ecological footprint as dependent variables instead of total ecological footprint.

In addition, the most important limitation of the study can be stated as an ongoing debate exists about the ecological footprint calculation that's used as an indicator of environmental quality in the study. According to Johannesson et al. (2020), small changes to a data point in the EF computation matrix can result in large changes in the computed value. Additionally, it is written that the emission values presented by the IPCC were derived using various estimates and averages. Obviously, Johannesson et al. (2018) has proven that the EF values for Iceland are inaccurate. They explained that the calculations were off due to the sectors being overly specialized in a particular field, and the sectors being very large when compared to the population. Therefore, calculating EF

values with local data in future studies and taking into account the specific specializations of countries in these calculations may lead to more accurate estimation results.

Appendix A

Figure A.1. Time Series Plot of Variables



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